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► To cite this version:

Frédérique de Vignemont. How many representations of the body?. Behavioral and Brain Sciences, 2007, 30 (2), pp.1-6. ijn_00169858

HAL Id: ijn_00169858

https://hal.science/ijn_00169858

Submitted on 5 Sep 2007

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Commentary Dijkerman & de Haan: Somatosensory processes subserving perception and action *Behavioral and Brain Sciences*, 30 (2), 2007.

How many representations of the body?

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Abstract: Based on functional differences, Dijkerman and de Haan emphasize the duality of somatosensory processing and therefore of body representations. But how many body representations do we really have? And what kind of criterion can we use to distinguish them? I review here the empirical and conceptual difficulties in drawing such distinctions and the way to progress.

The way we use information determines the way we encode it. Dijkerman & de Haan (D&dH) illustrate this general principle with somatosensory processing. Like vision and audition, proprioception can be either action oriented or recognition oriented. However, what characterizes proprioception from other sensory modalities is the role played by body representations. D&dH conclude that the dual somatosensory pathways give rise to two kinds of body representations: the body schema and the body image. What is the basis of this dualistic distinction? How many body representations do we really have?

One representation that integrates all of the different types of information into a unified

neuromatrix (Melzack 1992)? *Two* representations that are either based on functional criteria distinguishing the body image for recognition and the body schema for action (Gallagher 2005; Paillard 1999) or based on temporal criteria distinguishing the actual body from the habitual body (Merleau-Ponty 1945) or short-term and long-term body images (O'Shaughnessy 1995)? *Three* representations that, for a more fine-grained distinction within the body image, take apart visuospatial body map and body semantics (Schwoebel & Coslett 2005; Sirigu et al. 1991)?

The evidence provided to support the distinction between different kinds of body representations relies mainly on neuropsychological dissociations between deafferentation (disruption of body schema) and neglect or numbsense (disruption of body image) or between apraxia (disruption of body schema), autotopagnosia (disruption of structural body description), and body-specific aphasia (disruption of body semantics). However, neuropsychological evidence is open to interpretation. First, there are so many body deficits, and therefore so many possible dissociations, that one may end up with almost an infinite list of body representations. For instance, some patients cannot identify their own body parts only, whereas others cannot identify exclusively someone else's body parts (Felician et al. 2003). One would then have to make a further distinction between two types of structural description: for one's own body and for other people's bodies. Second, without a clear definition of what each type of body representation involves, it is hard to find conclusive clinical tests to assess the different levels of body representations in patients. For instance, autotopagnosia has been diagnosed by asking patients to *point* toward body parts, although one could argue that pointing requires not

only the body structural description, but also the body schema (Schwoebel & Coslett 2005).

A further problem to validate the distinction between multiple body representations is that there is almost a complete lack of experimentation outside of neuropsychology (except for, e.g., Kammers et al. 2006). D&dH emphasize the distinct neuroanatomical bases of somatosensory processing. However, the differences in activations that they describe may depend on the tasks rather than on underlying distinct body representations (Holmes & Spence 2006). We have to disentangle two alternatives: (a) one and the same representation used for different functions and (b) different representations specific to each function. To prove the latter hypothesis, one needs to show that what differs is not only the function, but also the content, of the representations. The function of body representation, whether it is action oriented or recognition oriented, might not provide such a clear criterion, contrary to what D&dH assume.

Action involves many different types of information about the body, which may not be encoded in the same format. On the one hand, one could distinguish the body as a target or as the mean (grouped together in the body schema in Figure 1 in the target article). Whereas the former is encoded in an egocentric frame of reference, like any other goal, this might not be true for the latter (Bermudez 1998). They are both action oriented, but their spatial perspectives are different. On the other hand, one could distinguish short-term information about body posture and long-term information about body constraints, like the size and the strength of the limbs (de Vignemont 2006). Again, both types of

information are necessary to plan a movement, but the dynamics are different.

Recognition covers an even wider scope of body information, including body posture and body size. The body image is said to include body percept, body concept, and body affect (Gallagher 2005). The dynamics may vary from short-term body sensations to long-term body properties (O'Shaughnessy 1995). A further level of complexity occurs for the body image because it can be applied both to one's own body and to someone else's body.

Why are all of these aspects part of one single category? The unitary function of the body image is far from obvious. It is often described as what is left over after the body schema. Breaking down the body image into pieces is not the optimal solution either. Indeed, the triadic distinction leaves out the emotional component of the body image. Does that mean that there would be four or even more kinds of body representation?

Shall we then give up on drawing distinctions between body representations? No, but one must be careful to avoid three main obstacles: (a) a lack of unity within each kind of body representation, (b) a lack of positive definition, and (c) a risk of infinite multiplication.

D&dH have made the first step by describing in detail the distinction for somatosensory processing. Further work needs to be done for body representations. To establish a taxonomy of body representations, one needs to describe not only the specific functions of body representations, but also their input (e.g., Does the weighting of each sensory modality in multimodal integration depend on the type of body representation?), their content (e.g., Are some body representations self-specific and others shared between self and other?), their dynamics (e.g., How quickly can body representations adjust to body

changes?), and their spatial frame of reference (e.g., Does the body schema/body image distinction overlap with the egocentric/allocentric distinction?). One may then be able to provide a full account of body representations.

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